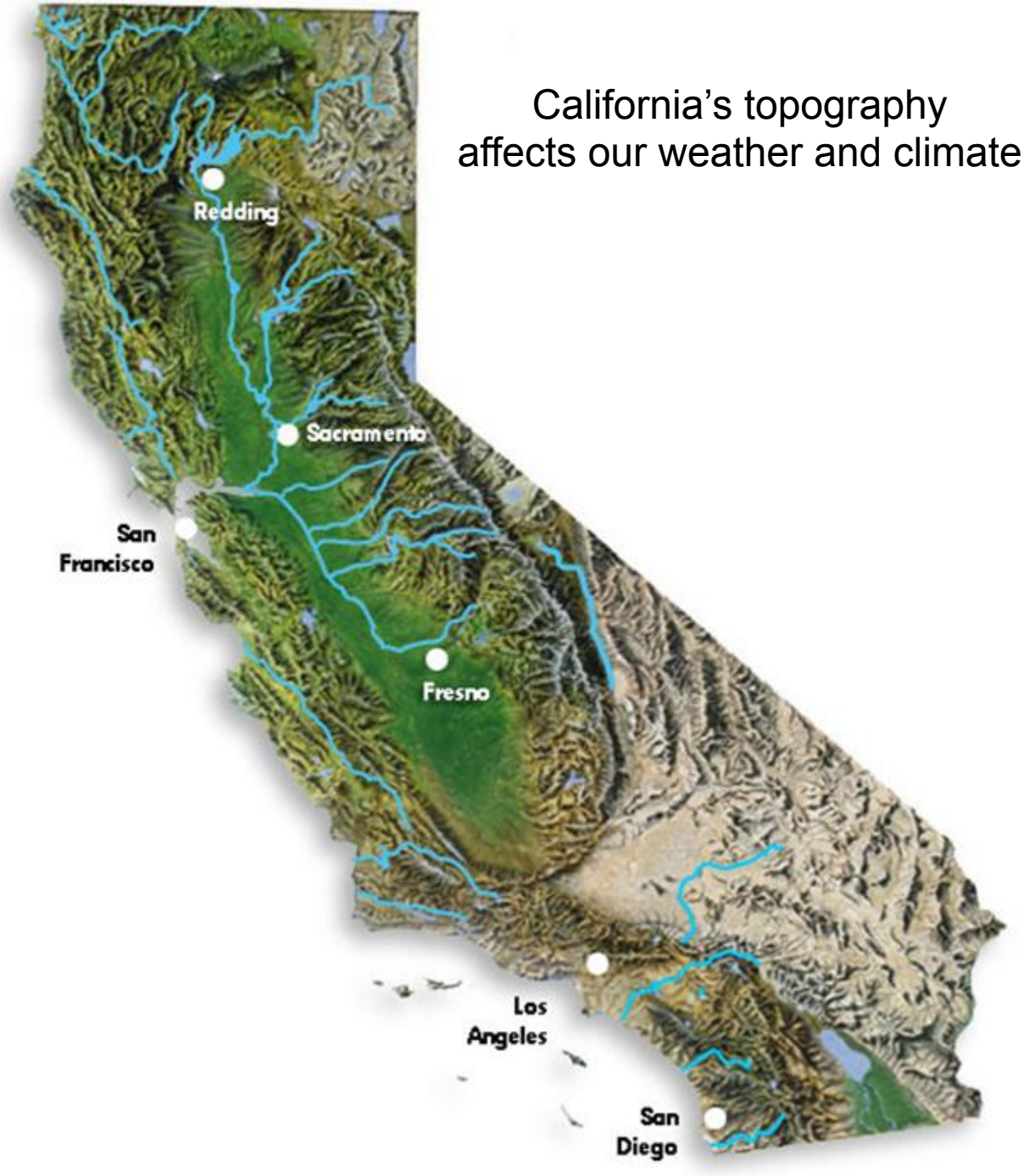
California Climate and Drought

Tales from 2012 to 2017

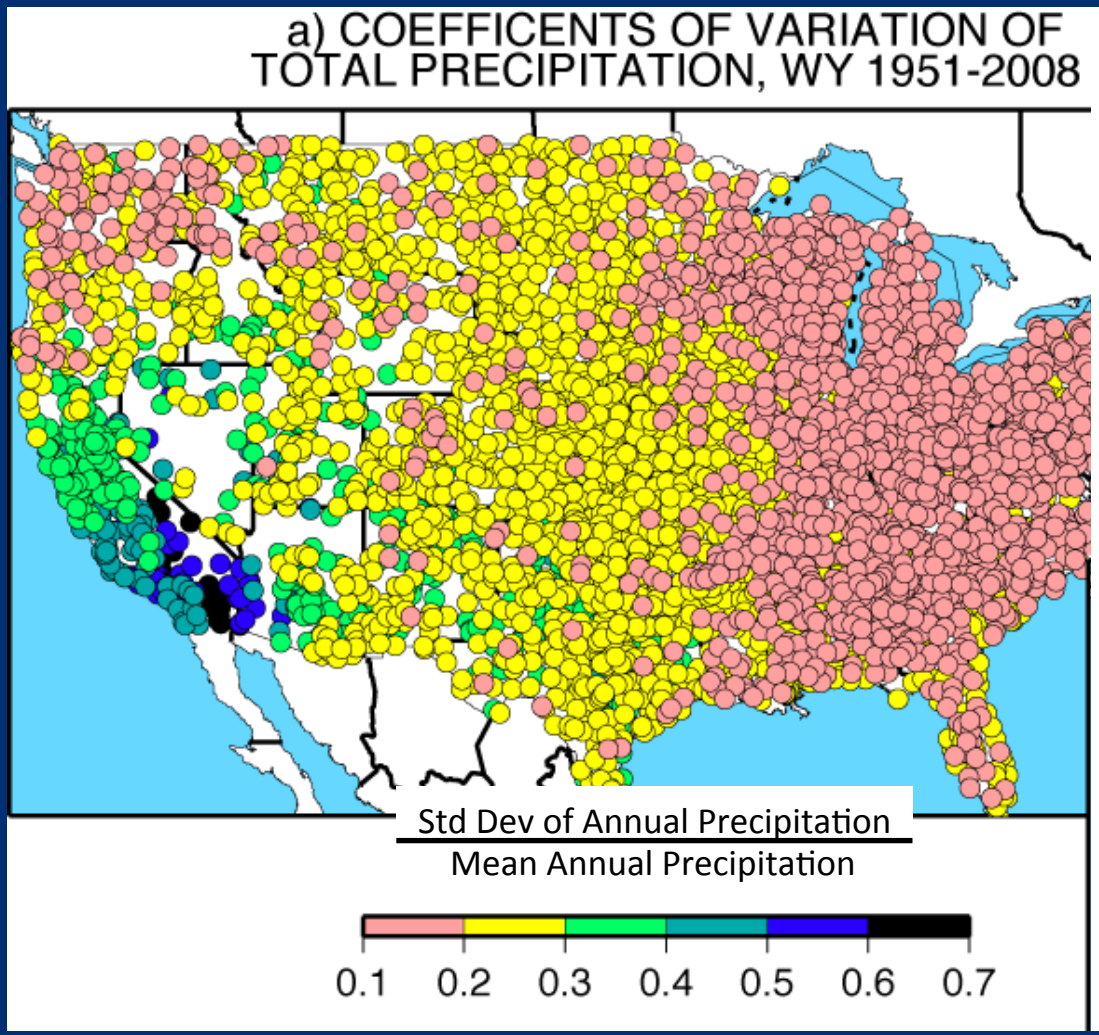
Talk Outline

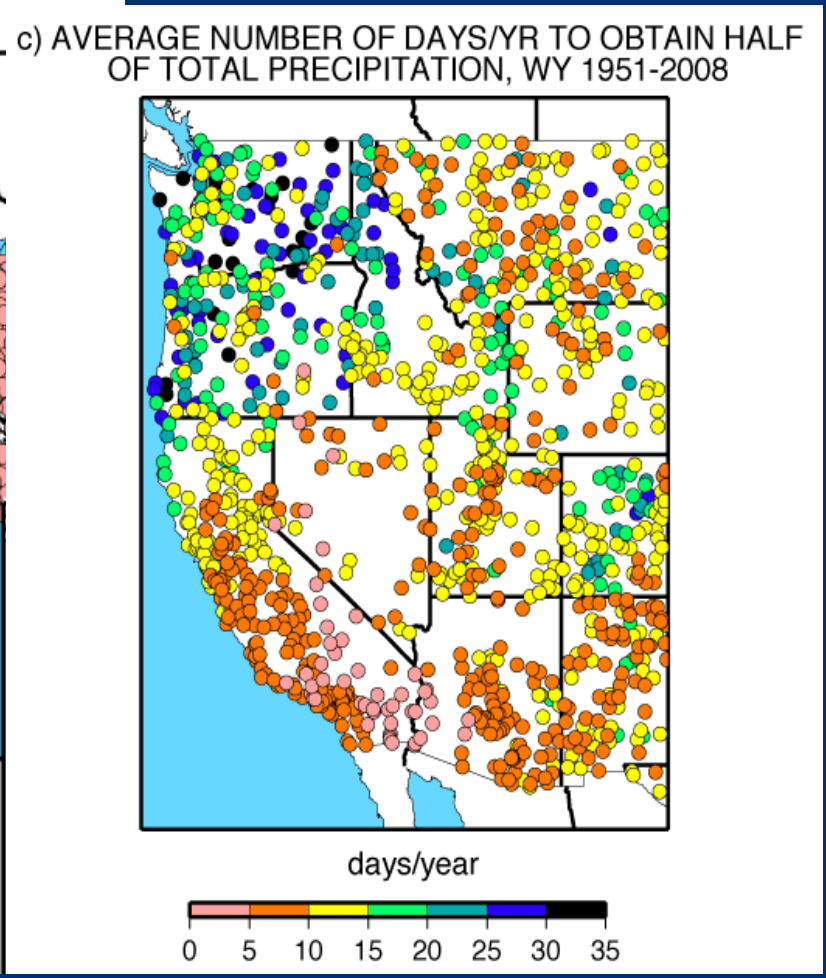
- Background
- What Happened
- Context
- Where to from here

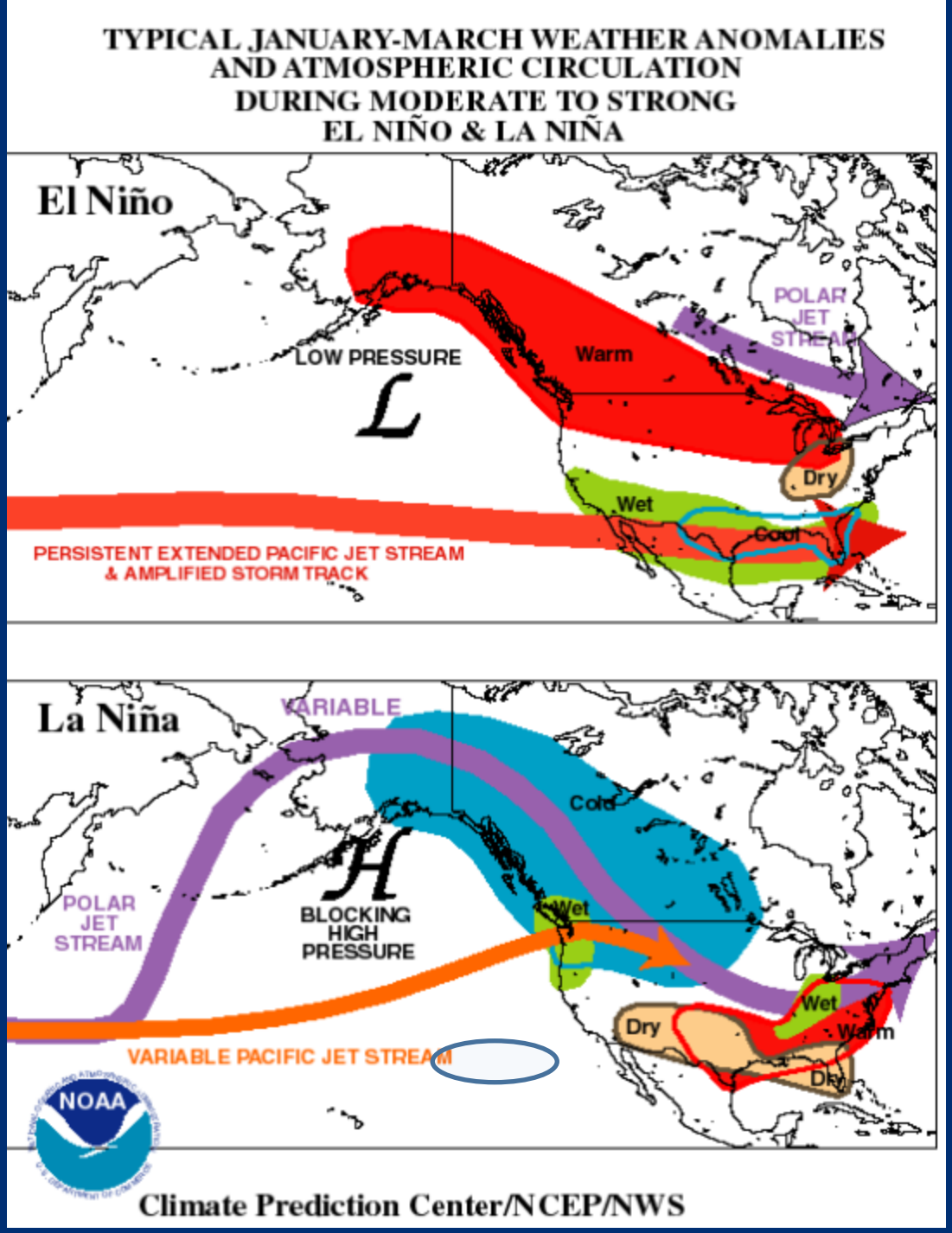
California's topography
affects our weather and climate



California and Variability

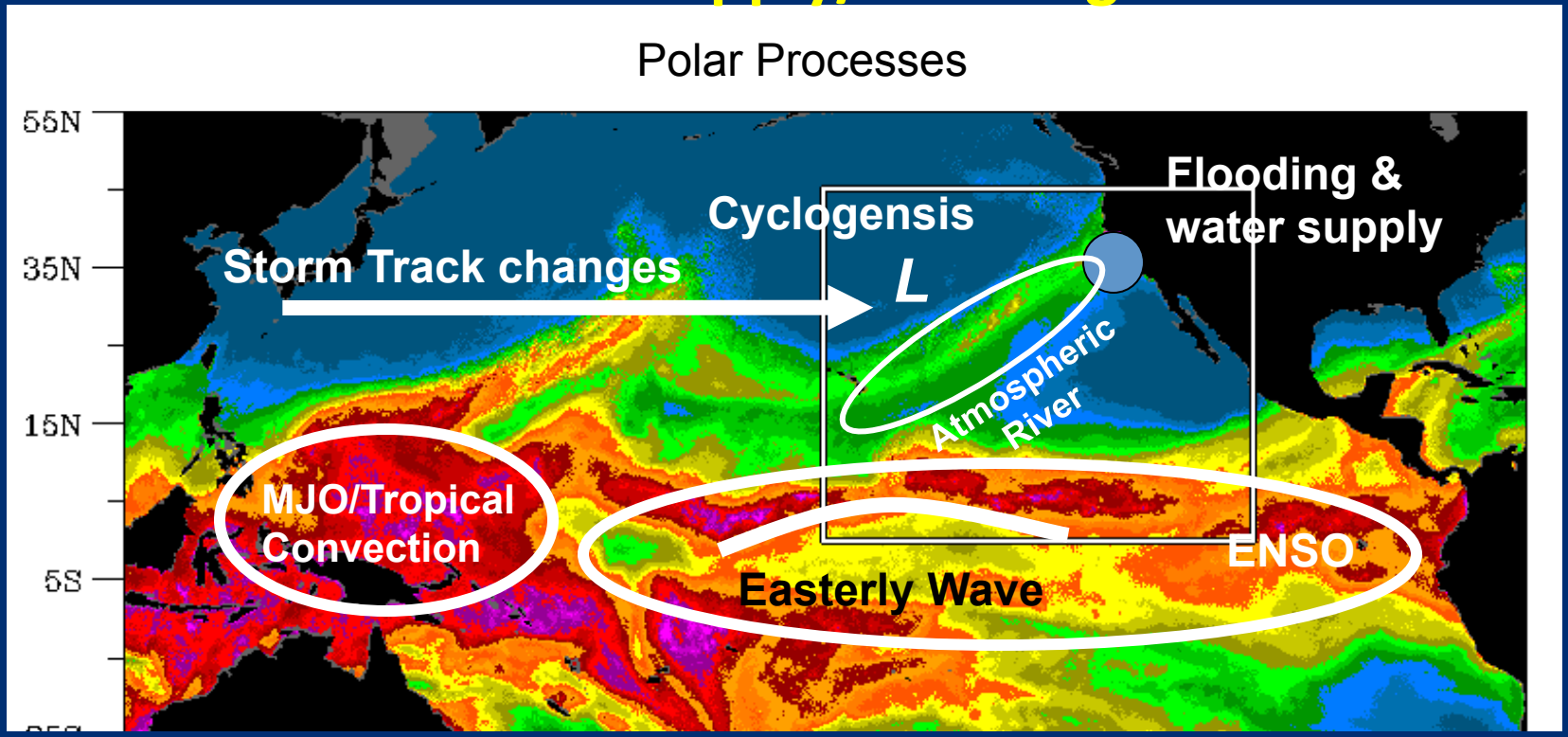






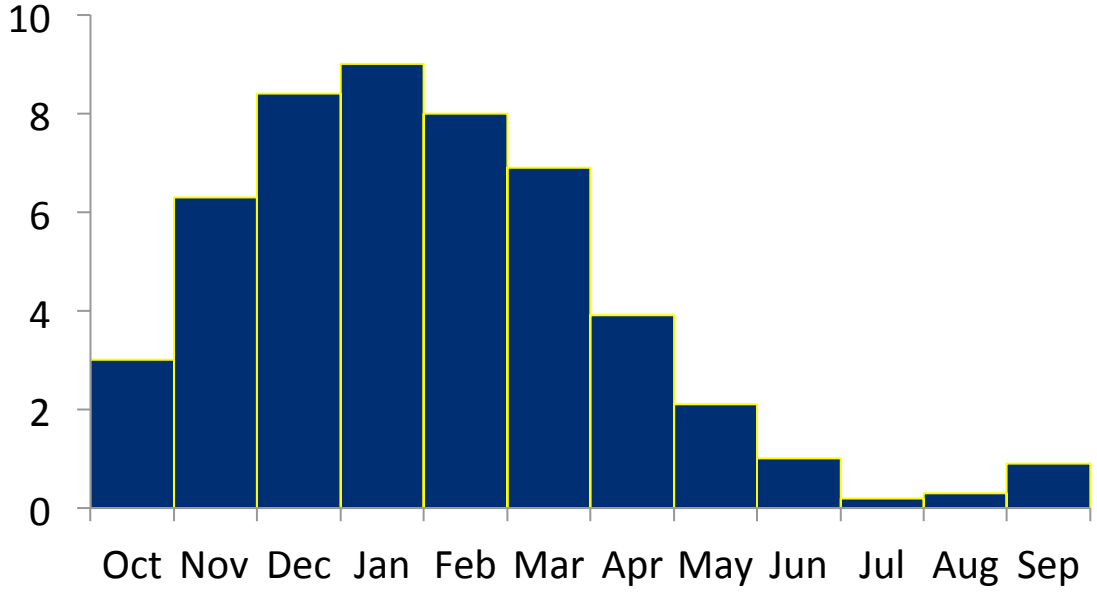
ENSO may not be predictive
for California, but it is still important

Key Phenomena Affecting California Water Supply/Flooding:

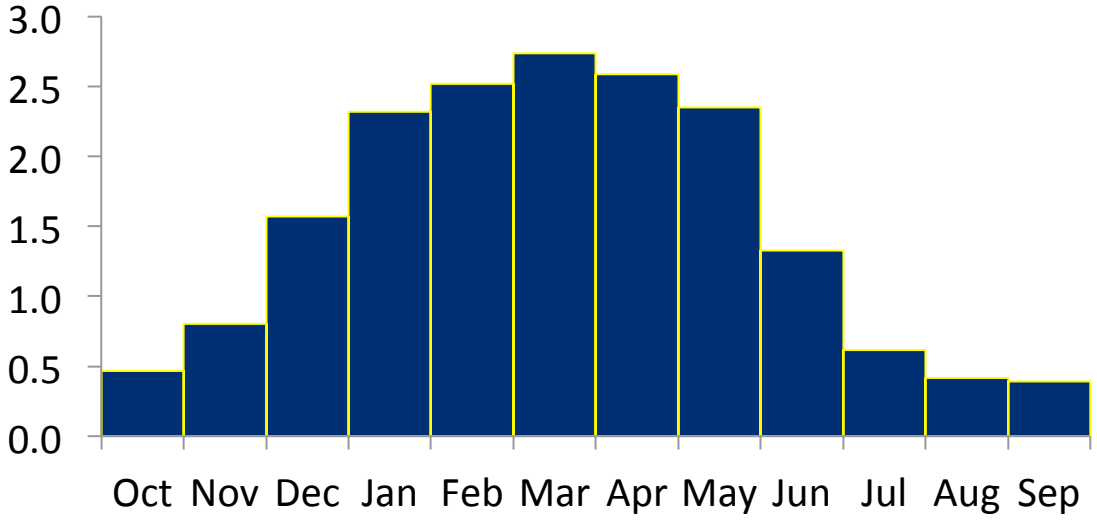


The size, number, and strength of atmospheric river events (ARs) result from the alignment of key physical processes operating on different space and time scales that will change with climate change

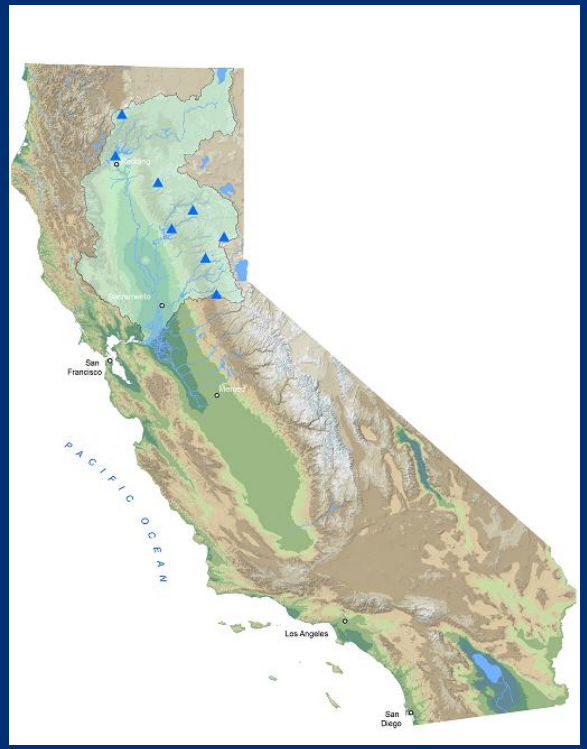
8 Station Precipitation Index (Inches)



Sacramento River Flow (MAF)

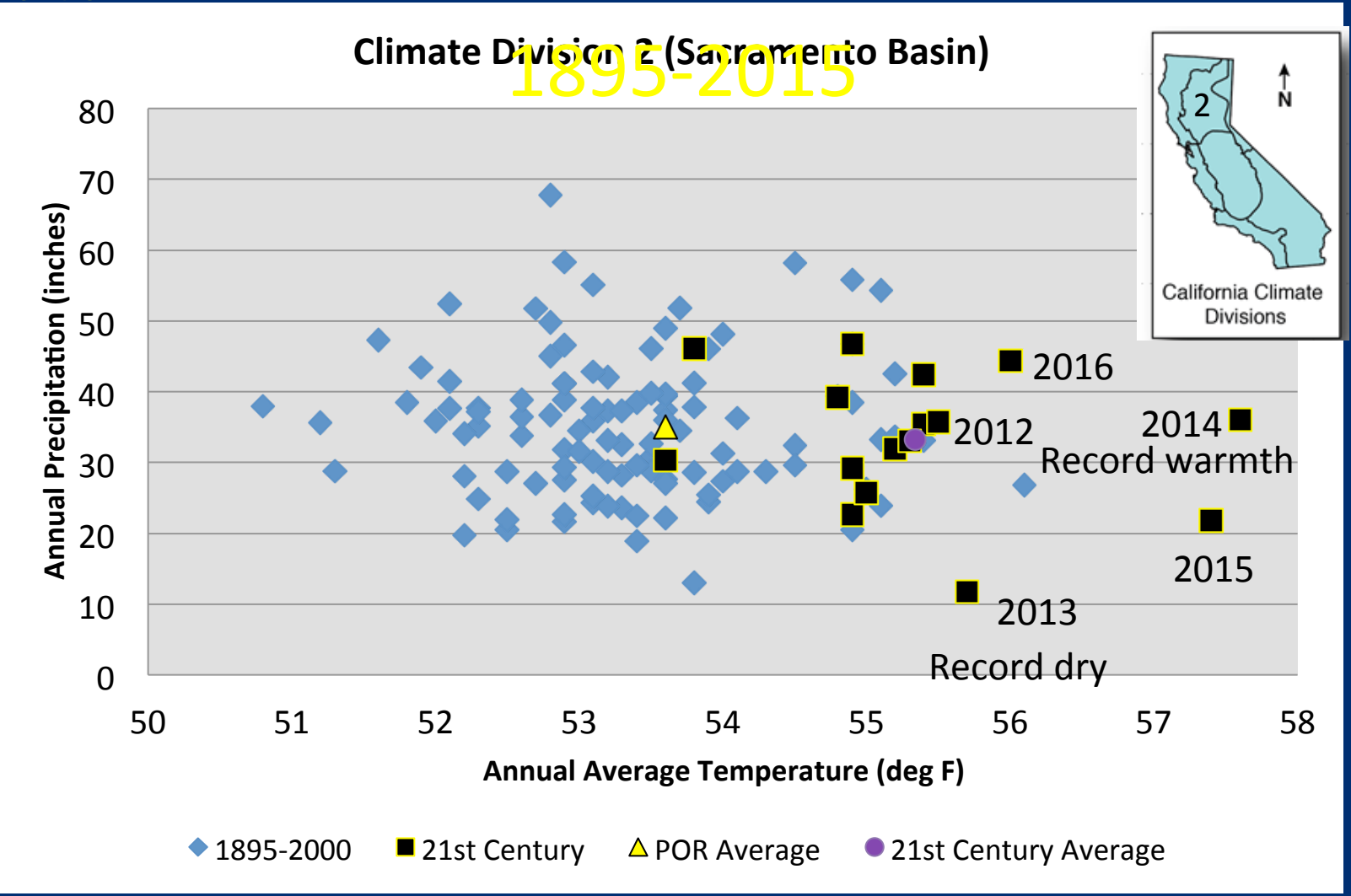


Important Region for CA Water Supply



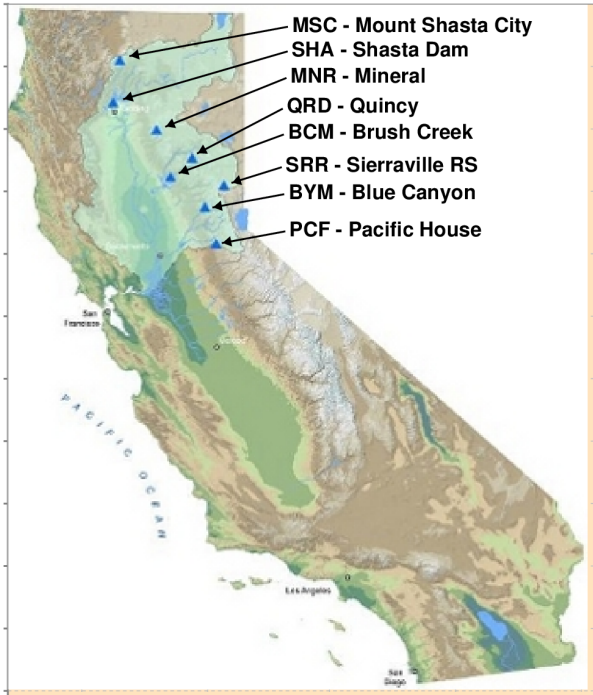
Period of Record Monthly Averages

NOAA Climate Division 2 Calendar Year Data



Source: NOAA Climate Division 2 Calendar Year Data

Northern Sierra Precipitation: 8-Station Index, April 06, 2015



Percent of Average for this Date: 75%

1982-1983 (wettest) 88.5

2005-2006 Daily Precip. 80.1

Average (1922-1998) 50.0

2012-2013 Daily Precip. 44.3

Current Daily Precip:31.9

2013-2014 Daily Precip. 31.3

1923-1924 (driest) 19.0 17.1

1976-1977 (2nd driest & driest thru Aug)

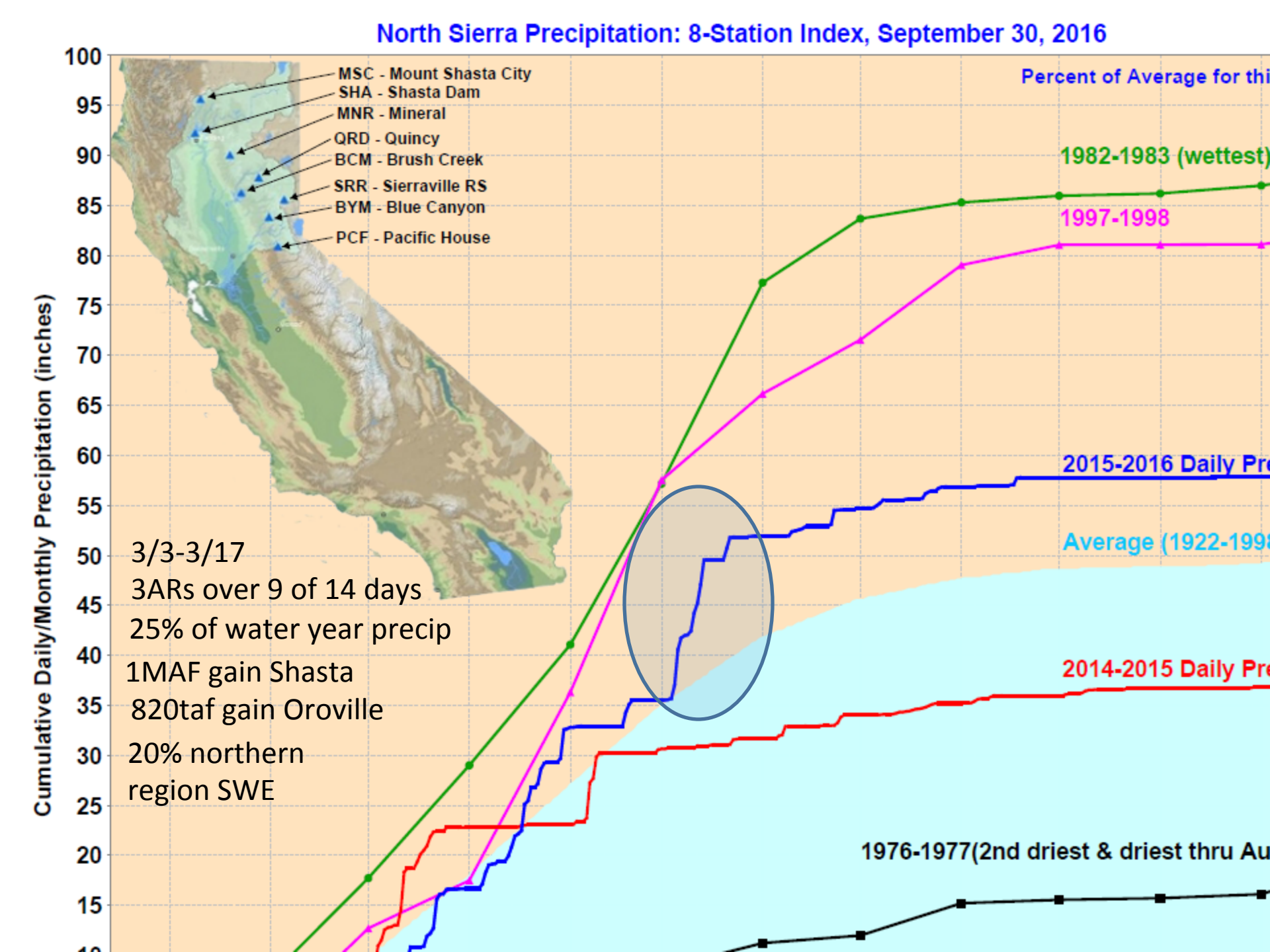
Cumulative Daily/Monthly Precipitation (inches)

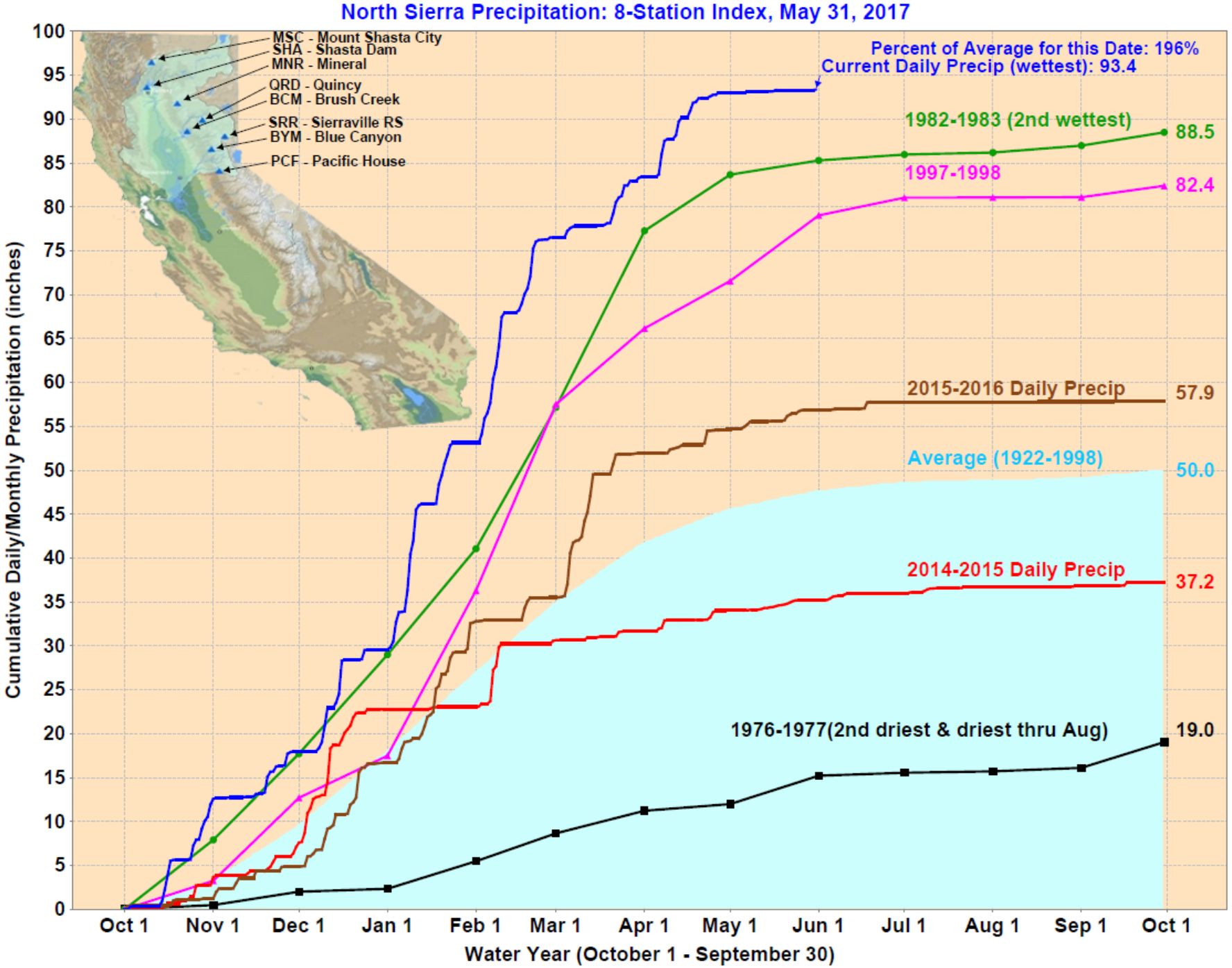
Total Water Year Precipitation

100 95 90 85 80 75 70 65 60 55 50 45 40 35 30 25 20 15 10 5 0

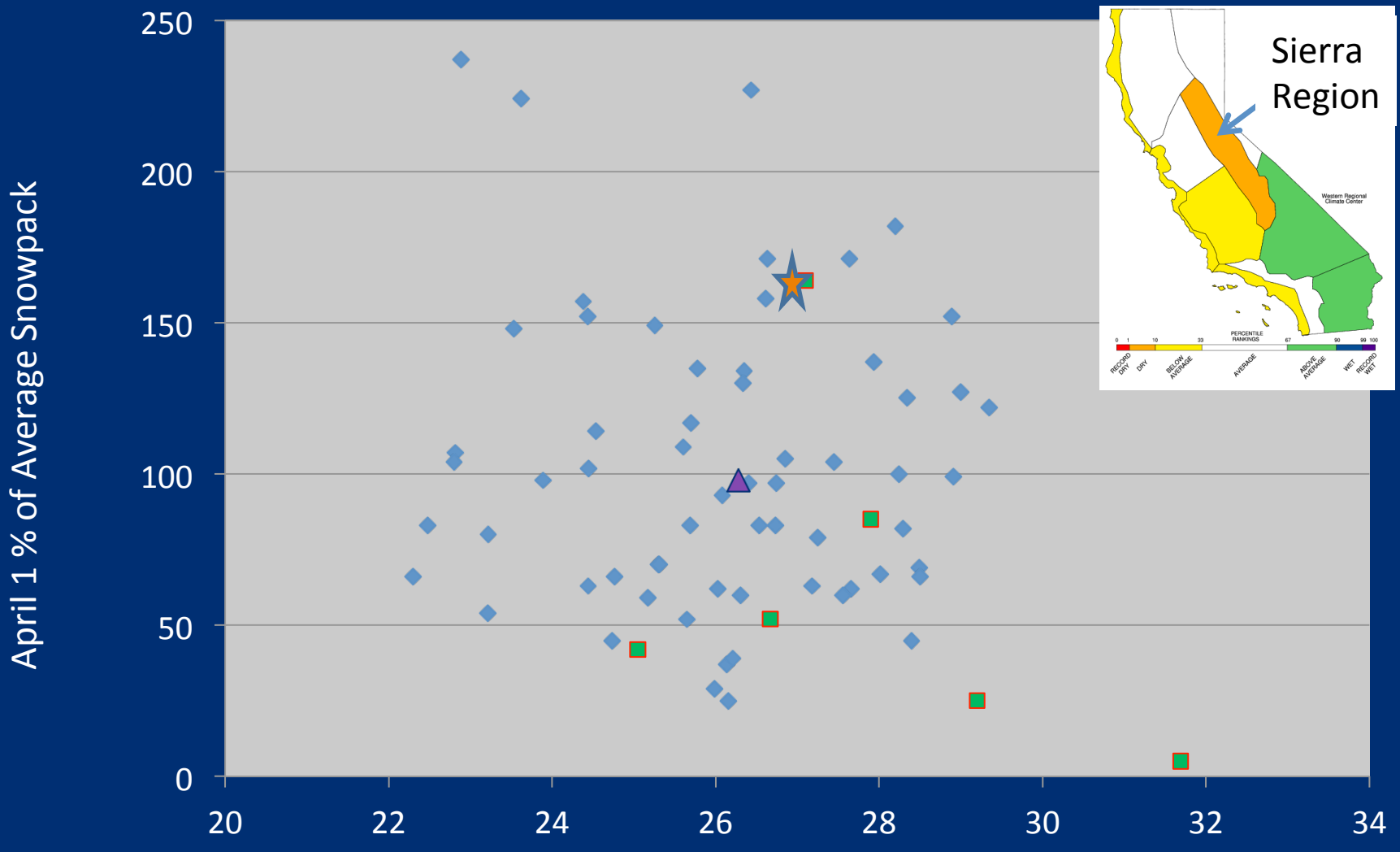
Oct 1 Nov 1 Dec 1 Jan 1 Feb 1 Mar 1 Apr 1 May 1 Jun 1 Jul 1 Aug 1 Sep 1 Oct 1

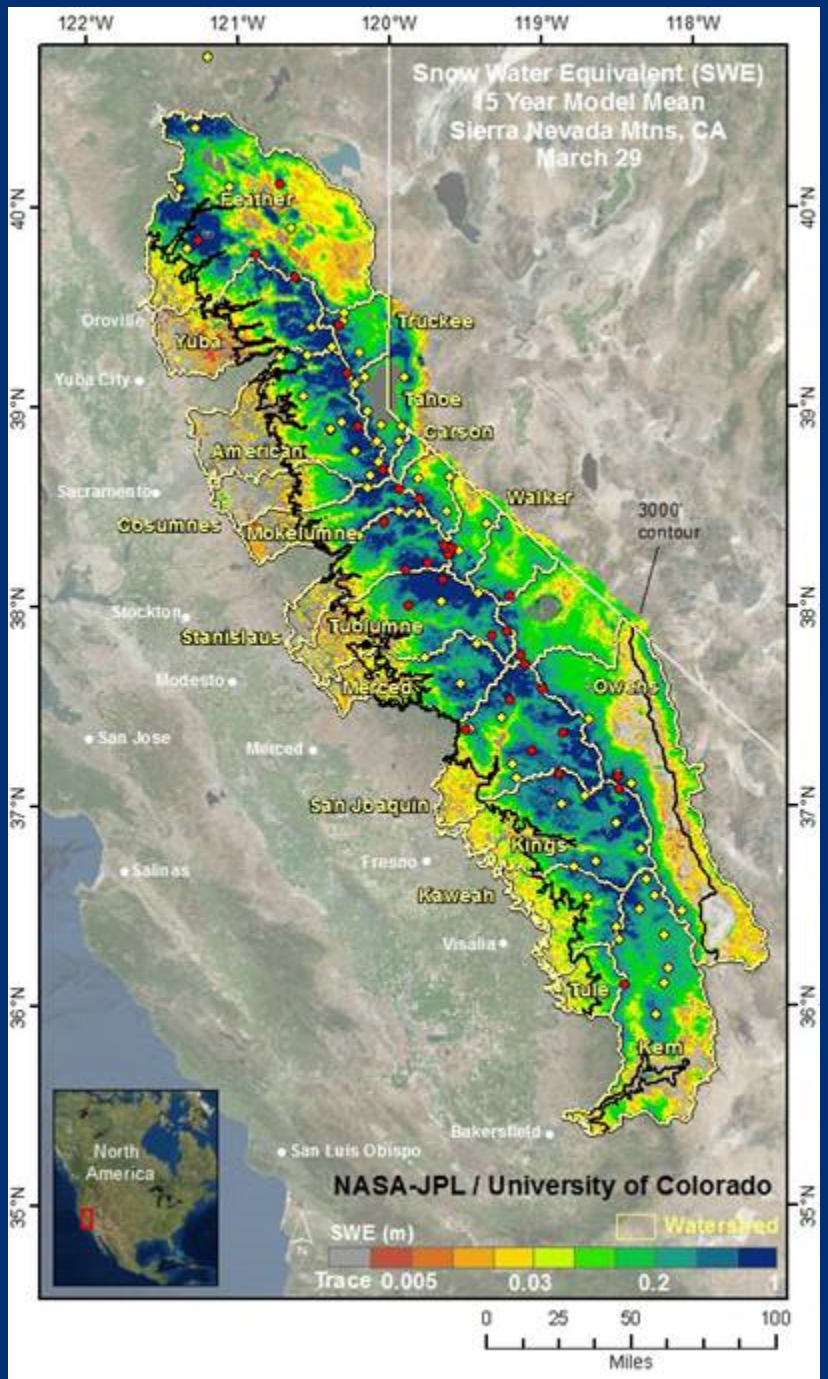
Water Year (October 1 - September 30)

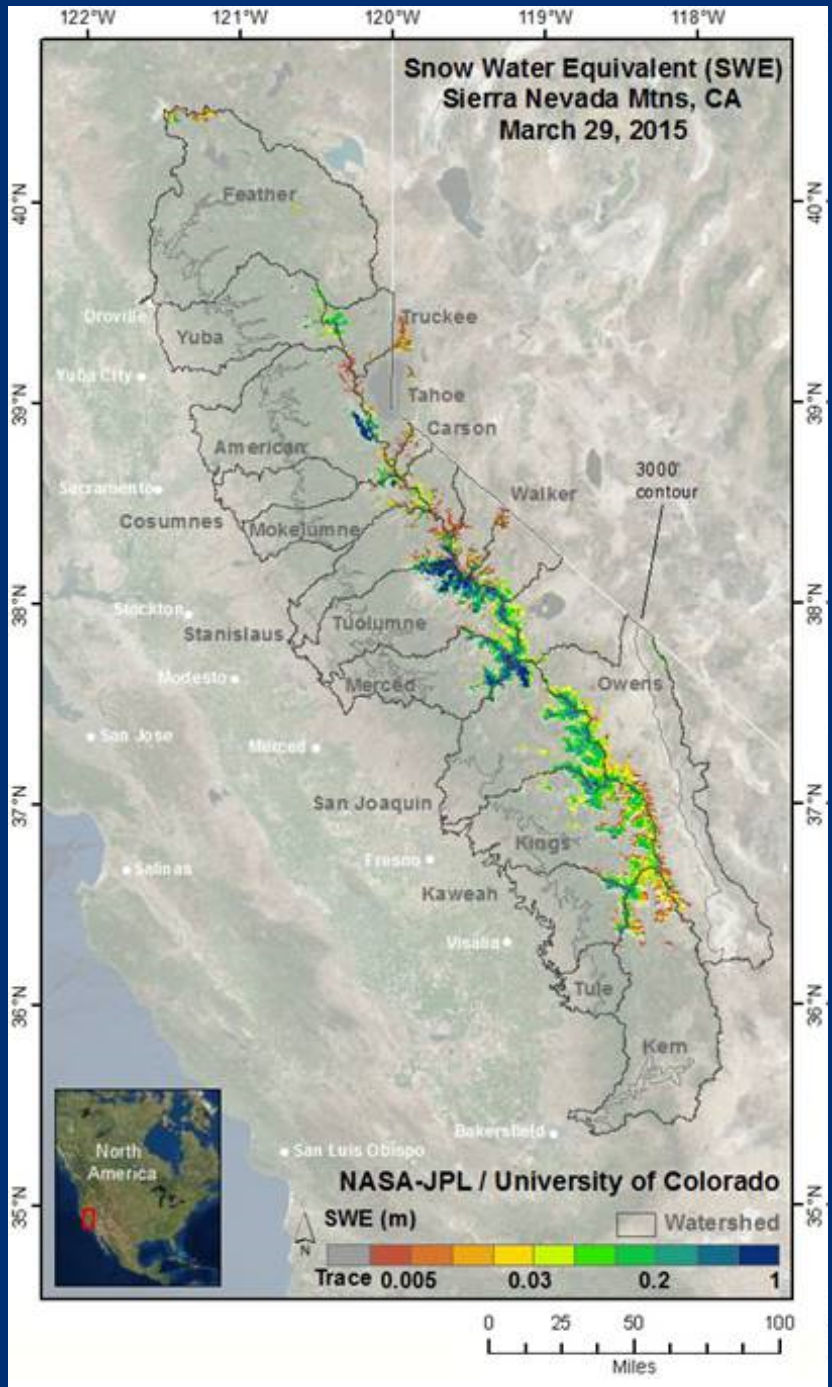

North Sierra Precipitation: 8-Station Index, September 30, 2016
Cumulative Daily/Monthly Precipitation (inches)
100
95
90
85
80
75
70
65
60
55
50
45
40
35
30
25
20
15
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
Percent of Average for thi
1982-1983 (wettest)
1997-1998
2015-2016 Daily Pr
Average (1922-199
2014-2015 Daily Pr
1976-1977(2nd driest & driest thru Au
3/3-3/17
3ARs over 9 of 14 days
25% of water year precip
1MAF gain Shasta
820taf gain Oroville
20% northern
region SWE


North Sierra Precipitation: 8-Station Index, May 31, 2017
MSC - Mount Shasta City
SHA - Shasta Dam
MNR - Mineral
QRD - Quincy
BCM - Brush Creek
SRR - Sierraville RS
BYM - Blue Canyon
PCF - Pacific House
Percent of Average for this Date: 196%
Current Daily Precip (wettest): 93.4
1982-1983 (2nd wettest)
88.5
1997-1998
82.4
2015-2016 Daily Precip
57.9
Average (1922-1998)
50.0
2014-2015 Daily Precip
37.2
1976-1977(2nd driest & driest thru Aug)
19.0
Cumulative Daily/Monthly Precipitation (inches)
Total Water Year Precipitation
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Oct 1
Nov 1
Dec 1
Jan 1
Feb 1
Mar 1
Apr 1
May 1
Jun 1
Jul 1
Aug 1
Sep 1
Oct 1
Water Year (October 1 - September 30)

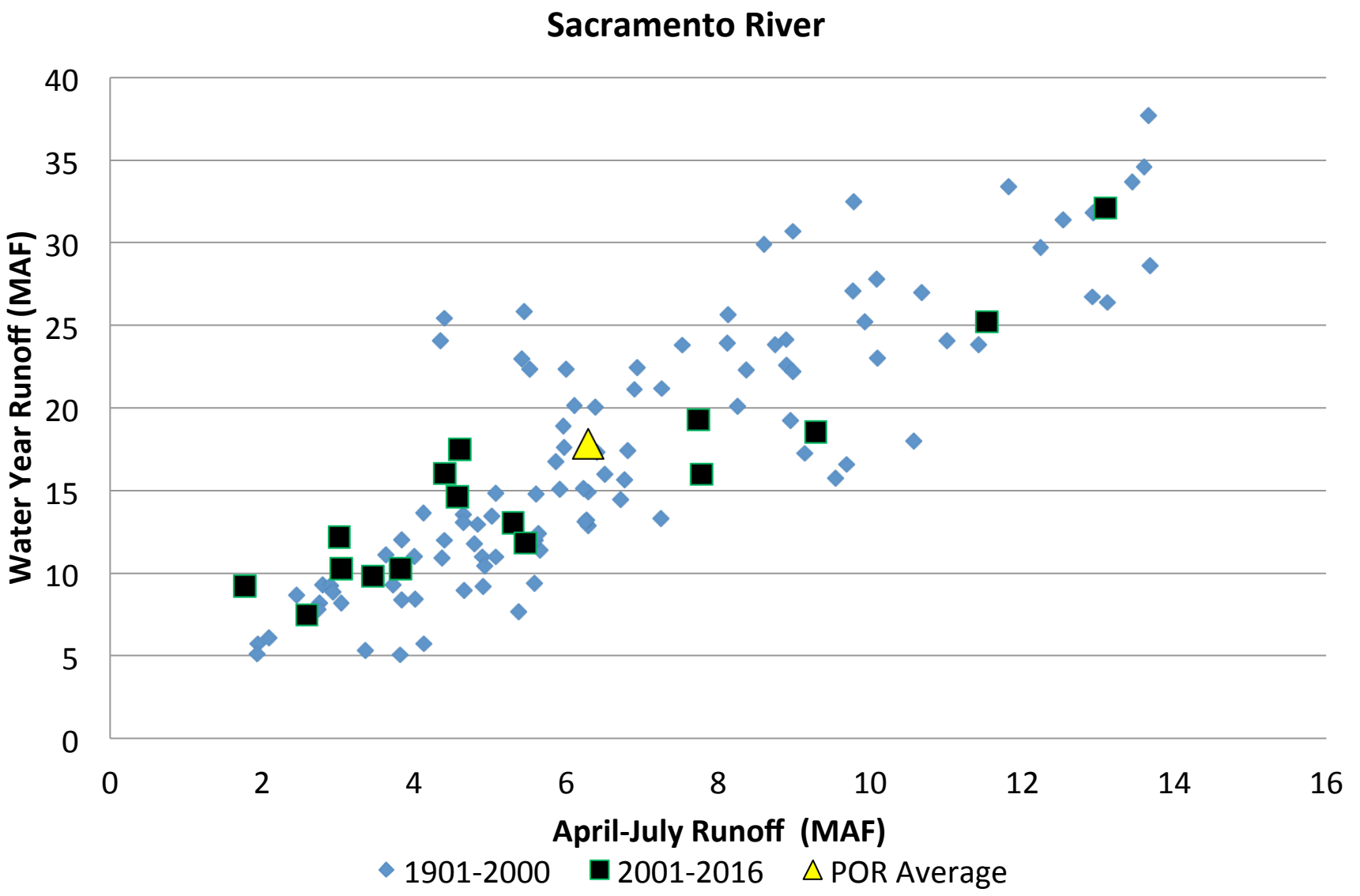
Statewide April 1 Snowpack versus Average Winter (DJF) Minimum Temperature

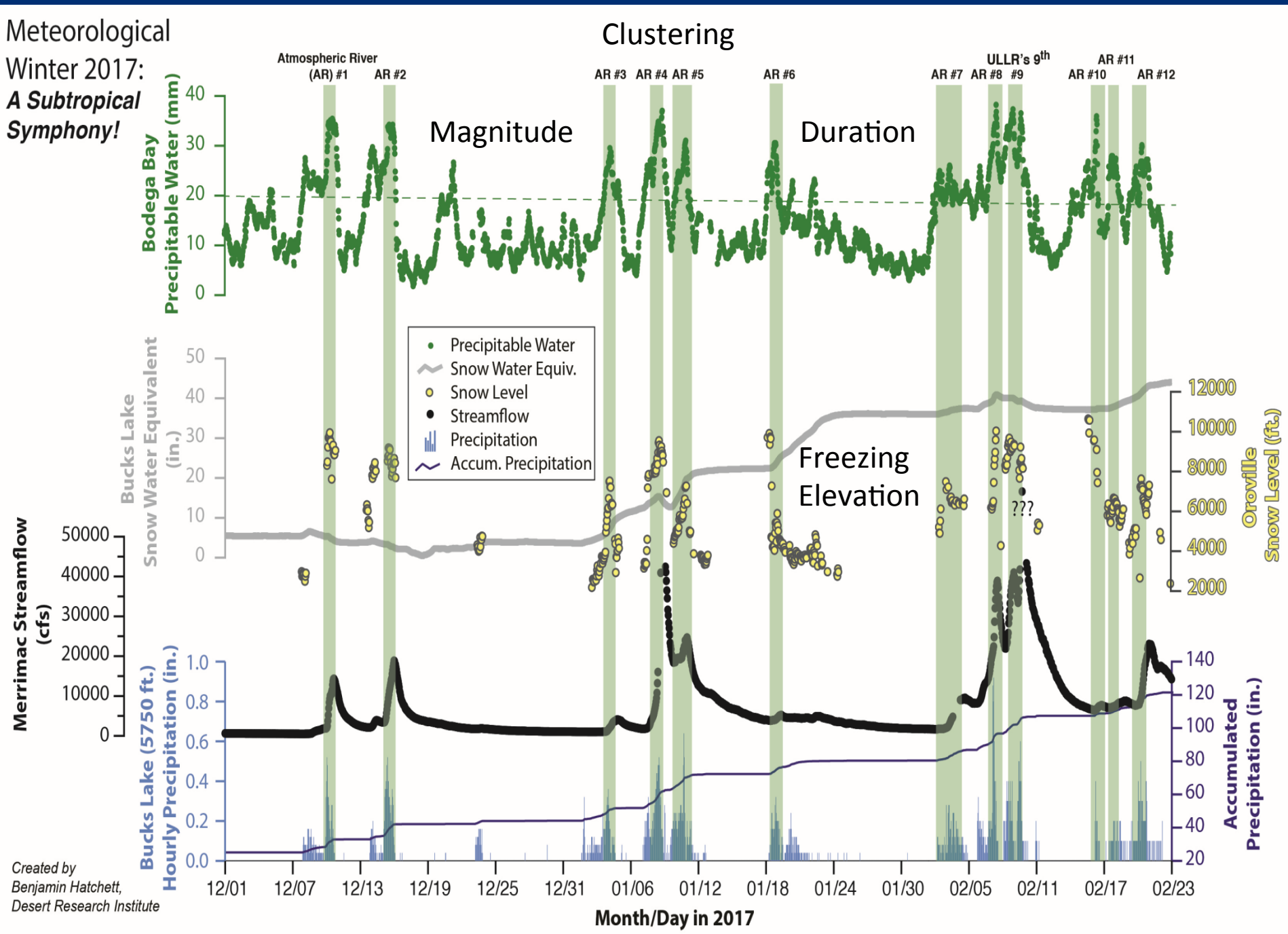


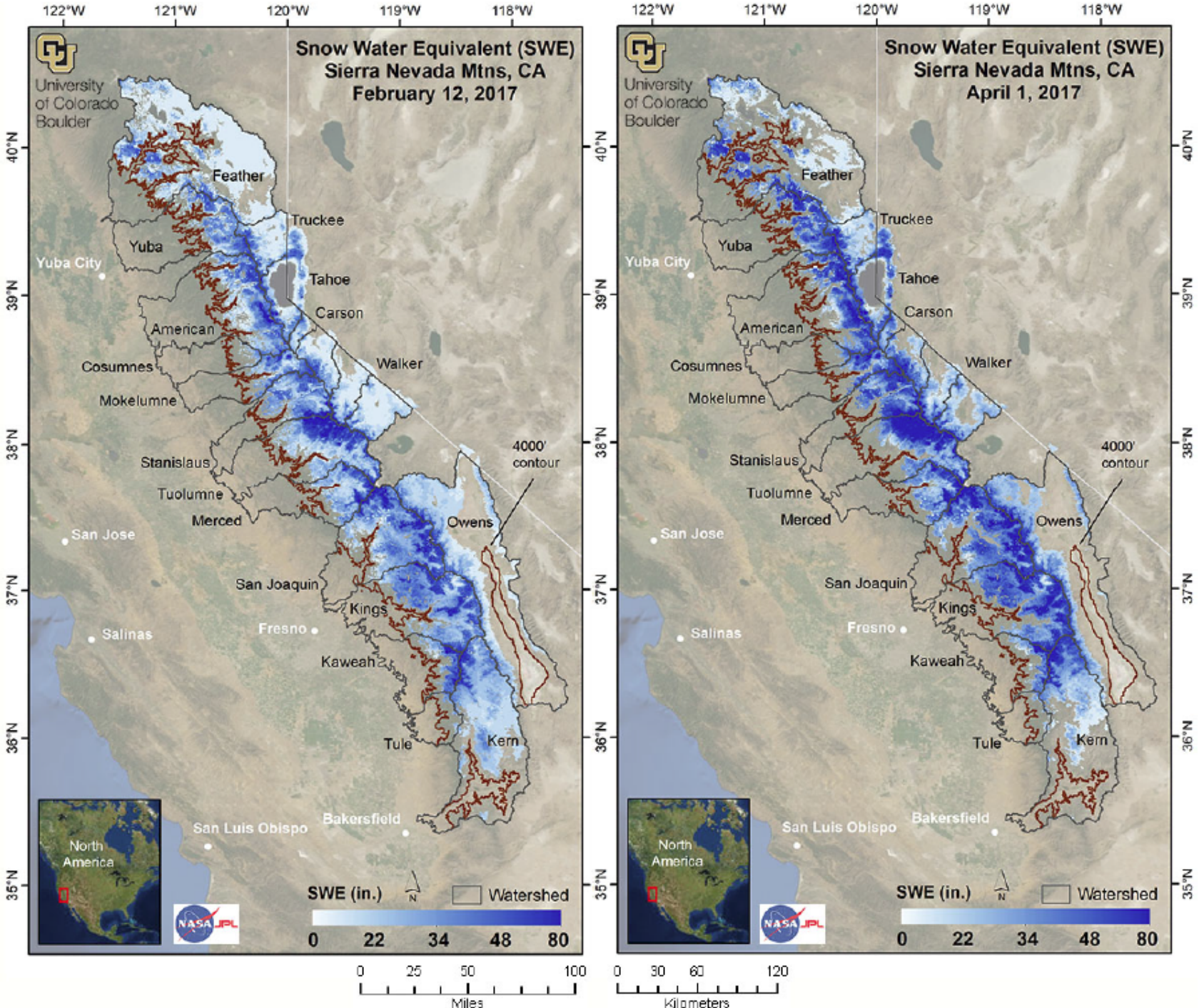

Snow Water Equivalent (SWE)
15 Year Model Mean
Sierra Nevada Mtns, CA
March 29
122°W
121°W
120°W
119°W
118°W
40°N
39°N
38°N
37°N
36°N
35°N
Feather
Oroville
Yuba
Yuba City
Truckee
Tahoe
Carson
American
Sacramento
Walker
3000' contour
Cosumnes
Mokelumne
Stockton
Stanislaus
Tuolumne
Modesto
Merced
Owens
San Jose
Salinas
San Joaquin
Kings
Fresno
Kaweah
Visalia
Tule
Kern
Bakersfield
San Luis Obispo
North America
NASA-JPL / University of Colorado
SWE (m)
Watershed
Trace
0.005
0.03
0.2
1
0
25
50
100
Miles


Snow Water Equivalent (SWE)
Sierra Nevada Mtns, CA
March 29, 2015
122°W
121°W
120°W
119°W
118°W
40°N
39°N
38°N
37°N
36°N
35°N
Feather
Oroville
Yuba
Yuba City
Truckee
Tahoe
Carson
American
Sacramento
Walker
3000' contour
Cosumnes
Mokelumne
Stockton
Stanislaus
Tuolumne
Modesto
Merced
Owens
San Jose
Salinas
San Joaquin
Kings
Fresno
Kaweah
Visalia
Tule
Kern
Bakersfield
San Luis Obispo
North America
NASA-JPL / University of Colorado
SWE (m)
Watershed
Trace
0.005
0.03
0.2
1
0
25
50
100
Miles

21st Century Droughts on the Sacramento River




Meteorological Winter 2017:
A Subtropical Symphony!
Clustering
Magnitude
Duration
Freezing Elevation
Atmospheric River (AR) #1
AR #2
AR #3
AR #4
AR #5
AR #6
AR #7
AR #8
ULLR's 9th #9
AR #10
AR #11
AR #12
Bodega Bay Precipitable Water (mm)
Bucks Lake Snow Water Equivalent (in.)
Precipitable Water
Snow Water Equiv.
Snow Level
Streamflow
Precipitation
Accum. Precipitation
Oroville Snow Level (ft.)
Merrimac Streamflow (cfs)
Bucks Lake (5750 ft.) Hourly Precipitation (in.)
Accumulated Precipitation (in.)
???
12/01
12/07
12/13
12/19
12/25
12/31
01/06
01/12
01/18
01/24
01/30
02/05
02/11
02/17
02/23
Month/Day in 2017
Created by Benjamin Hatchett, Desert Research Institute


Snow Water Equivalent (SWE)
Sierra Nevada Mtns, CA
February 12, 2017
University of Colorado Boulder
Snow Water Equivalent (SWE)
Sierra Nevada Mtns, CA
April 1, 2017
University of Colorado Boulder
122°W
121°W
120°W
119°W
118°W
40°N
39°N
38°N
37°N
36°N
35°N
Feather
Truckee
Yuba
Yuba City
Tahoe
Carson
American
Cosumnes
Walker
Mokelumne
Stanislaus
4000' contour
Tuolumne
Merced
Owens
San Jose
San Joaquin
Kings
Salinas
Fresno
Kaweah
Tule
Kern
San Luis Obispo
Bakersfield
North America
SWE (in.)
Watershed
0
22
34
48
80
0
25
50
100
Miles
0
30
60
120
Kilometers

Looking towards Sutter Buttes and Tisdale Weir
Feb 18, 2017

Summarizing thoughts

- 21st century droughts have shown record-setting characteristics and are warmer than 20th century counterparts. WY2017 has added new records on the wet side.

- Atmospheric river events provide significant inputs into annual precipitation totals. The number, timing and characteristics of each event and the accumulated events are important for both water supply and flood management.

- The ability to manage the incoming runoff volumes is key to water management in CA

Summarizing Thoughts

- A warmer world will likely involve more variability and stronger pulses of water input to California (floods within droughts)
- The ability to manage water will increasingly rely on ability to forecast events and manage projects and systems nimbly with observations and forecasts
- Forecasting across time scales from events to water years offers opportunity to set expectations for water management and possibly more as warming continues

Email: Michael.L.Anderson@water.ca.gov